II. The Relations of Paleobotany to Botany

3. *Ecology*

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As I understand the object of a symposium it is not to provide opportunity for the reading of exhaustive or highly technical dissertations, or for the presentation of new material, but rather to present recognized facts as clearly as may be, with recent interpretations of their meaning or significance, in order to enlist interest in and to stimulate discussion of the subject under consideration; and this seems to have been the view which was taken by those who have preceded me. In such connection it is my privilege to present the claims of ecology to recognition, in indicating the relations between botany and paleobotany.

Plant ecology, as the term is commonly defined and understood, is that branch of botany which deals with the study of the interrelations of plants and their relations to environment. As a distinct science it is practically a product of the present generation. I do not know exactly when the term was first employed in scientific literature, but it certainly was not in general use in connection with botany at the time of my earliest contributions to the subject, and I did not then know that I was dealing with ecology when discussing certain floras and their accompanying geologic and physiographic features of environment.

The ecologic relations between botany and paleobotany are mostly concerned with the problems of phytogeography. Paleobotany has supplied the explanations of numerous puzzling facts in regard to the geographic isolation of certain genera; the occurrence of some genus or species only in certain widely separated regions of the earth; and the problems in connection with many endemic floras. Indeed the phenomena of plant distribution in

general at the present time would be lacking in logical or adequate explanation but for the facts which have been brought to light by the study of fossil plants in regard to distribution in the past. Many such instances might be cited, but for the purposes of this symposium a few of the most striking only need be recalled to serve as concrete examples of the general abstract propositions.

In the earlier part of the last century, when the science of paleobotany was in its infancy, and much that we now know about living plants had not been learned, numerous remains of coniferous trees were found in Europe and elsewhere in the Old World, in deposits of relatively recent geologic age. For the most part these remains were either identified as living genera or were given generic names designed to indicate their nearest apparent relationships with such (*Pinites, Taxites, Araucarites,* etc.). Other similar remains, however, which could not be satisfactorily compared with any living ones, were given new generic names. Among these latter may be mentioned certain small cones associated with leafy twigs, which were assumed at the time to represent an extinct coniferous genus. Large areas of the New World, however, were yet unexplored and many hitherto unknown living genera were awaiting discovery and description. One of these was *Sequoia,* a genus of two species only, confined in their distribution to scattered groves on the western coast of the United States. Ecology was an unknown science when these groves were discovered, but the relatively limited number of the individual trees, and their geographic isolation, at once attracted attention and aroused interest and discussion in regard to their ancestry and the phenomenon of their peculiar distribution. Paleobotany supplied the desired information. When the generic characters of *Sequoia* were made known they were seen to be identical with those of the supposed extinct fossil coniferous genus of the Old World. Further than this, however, similar remains, comprising numerous different species, were sub-

sequently found extending through Siberia to the eastern coast of Asia and through Europe, Iceland, Greenland and the Arctic regions to Alaska, and thence southward to the home of the two remaining living species on the western coast of North America. The phytogeographic problem of the genus *Sequoia,* as we know it to-day, was thus resolved into the geologic problem of the causes which produced the climatic changes resulting in the extinction of the genus over vast areas where it formerly existed, and the total extinction of all except two of the numerous species by which it was formerly represented. Modern areal *limitation* of the genus was thus shown by paleobotany to be a result of former areal *elimination.*

(Incidentally it may be remarked that this example also involves a question of nomenclature which, however, I trust our chairman may declare to be not germane to the subject and hence ineligible for discussion. *It is one of the few instances in which a genus was known and named as a fossil before it was discovered and named in its living form.*)

The genus *Taxodium,* comprising two, or possibly three living species, is confined to the southern United States and Mexico, so far as its present distribution is concerned. Up to the close of the Tertiary period, however, it flourished throughout what are now the temperate and arctic zones of North America and Eurasia,—not only the genus, but apparently the identical species yet living and others now extinct. Paleobotany has adduced ample proof of these facts, so that, as in the case of *Sequoia,* the present distribution of *Taxodium* is explained as merely the result of its elimination from other regions where it formerly existed.

The monotypic genus *Ginkgo,* which by many is also regarded as representing a monotypic family and order, is confined, so far as its natural distribution is concerned, to eastern China and Japan. No known facts could adequately account for its taxonomic and geographic isolation until paleobotany revealed the multiplicity of its ex-

tinct specific and allied generic forms, and its former wide distribution throughout the Eurasian and North American continents.

Another monotypic living genus, *Sassafras,* limited in its present distribution to eastern North America, represents an ancient type of angiosperm vegetation whose fossil remains have been found not only throughout North America, but also in many parts of the Old World.

These are merely a few of the many examples of generic isolation—geographic and taxonomic—the explanations of which have been supplied by the study of paleobotany.

Other apparent peculiarities of distribution, such as are represented in our living flora by *Liriodendron* and *Nelumbo,* genera which are restricted to eastern Asia, eastern North America and the central American regions, are exceedingly difficult to explain satisfactorily on any theory of migration in recent times; and the theory of origin *de novo* in each of the widely separated regions is too thoroughly discredited to merit discussion. None of the known facts of recent plant migration, or evolution, or mutation, are adequate to explain the conditions as we now find them. Paleobotany, however, has demonstrated that such apparent peculiarities of generic distribution are readily explained when the facts of former distribution are ascertained. Each of these genera was formerly world-wide in its distribution and prolific in species; but changes in environment caused their extinction in all except the widely separated regions which they now inhabit, reducing the species of *Nelumbo* to two, and of *Liriodendron* to one. What have been regarded as problems of distribution, explainable by improbable theories of migration or evolution, have thus been shown by the facts of paleobotany to be merely some of the many examples of isolation due to elimination in intermediate regions.

The peculiar endemic flora of Australia did not originate *de novo* by reason of its isolation. Paleobotany has shown that the living endemic flora of Australia in many

of its characteristic elements, such as the genus *Eucalyptus,* represents what the general vegetation of the entire earth was like at the close of Mesozoic time, when the continent of Australia was isolated from the rest of the world. Elsewhere than in Australia climatic and physiographic changes subsequently eliminated the Mesozoic types of vegetation and evolved new ones; but in Australia the conditions remained almost stationary, and that continent to-day, so far as its native flora and fauna are concerned, is still in a late Mesozoic or early Neozoic stage of development. It is an endemic flora not because it has evolved new types by reason of its isolation, but because it has remained stationary by virtue of this reason, while the great bulk of the world's vegetation has changed.

And so the paleobotanist extends the right hand of fellowship to the botanist and says, "when you are puzzled, or in doubt, don't despair, come to us," for individually or collectively we can, probably, suggest reasonable explanations, not only as to why living plants have come to be *where* they are, but also how they have come to be *what* they are.